An Overview of the Use of Remote Sensing to Identify Wetlands

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Importance of Wetlands

- Provide important ecosystem functions and processes
  - Biological diversity
  - Habitat for wildlife
  - Filters for pollutant discharge (i.e., kidneys of the ecosystem)
  - Hydrologic and biogeochemical flux and storage

Status of Wetlands in US

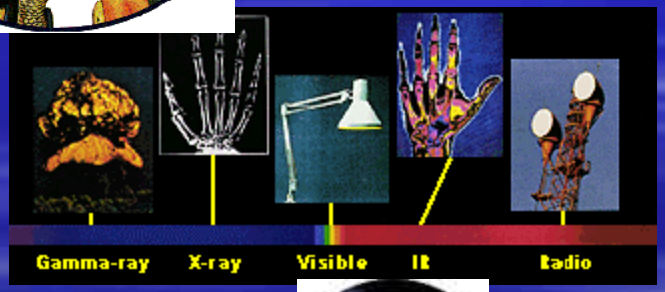
- Estimated that more than half of the total area of wetlands in the US has been lost or degraded because of:
  - Agricultural
  - Urban
  - Industrial
- USFWS has completed a comprehensive National Wetlands Inventory (NWI) using aerial photography

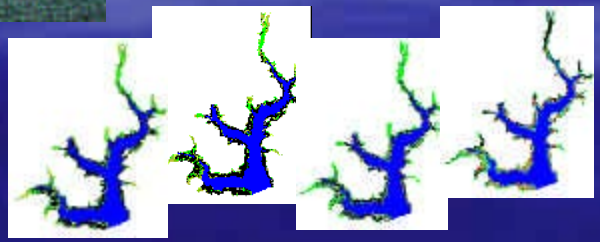
Types of Wetlands

- EPA has classified wetlands into the following types:
  - Marshes
    - Tidal
    - Nontidal
      - Wet Meadows
      - Prairie
      - Potholes
      - Vernal Pools
      - Playa Lakes
  - Swamps
    - Forested Swamps
      - Bottomland Hardwoods
    - Shrub Swamps
      - Mangrove Swamps
  - Bogs
    - Northern Bogs
    - Pocosins
  - Fens

Remote Sensing of Wetlands

- Why use remote sensing for wetlands?
  - "Bird's eye" view (large-area inventory)
  - Observation beyond the visible portion of the electro-magnetic spectrum (EMS)
  - Multi-stage (multi-scale) observations
  - Multi-temporal (frequent revisit) for monitoring and change detection





Hardware for Remote Sensing of Wetlands

- Ground-based Spectrometers

FieldSpec Pro

- Airborne Cameras

RMK Top Aerial Camera

- Airborne Multispectral/ Hyperspectral Scanners

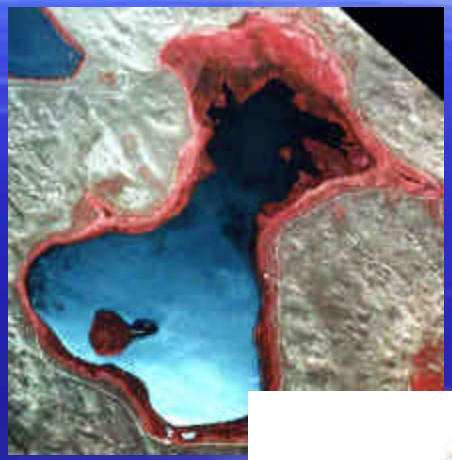
AISA

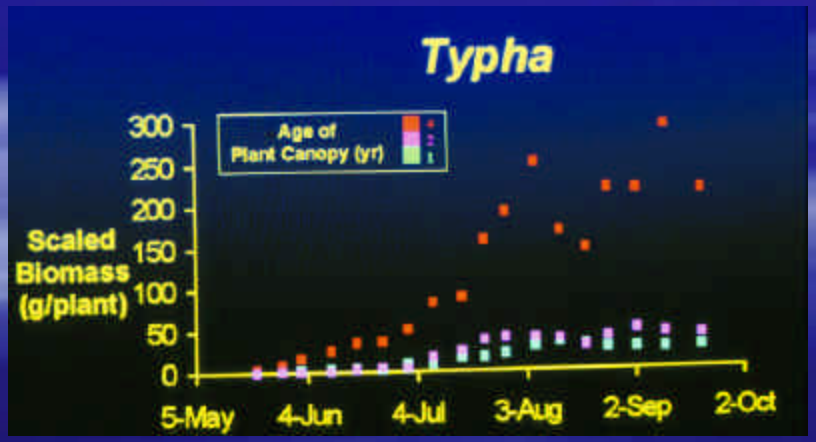
- Satellite Sensor Systems

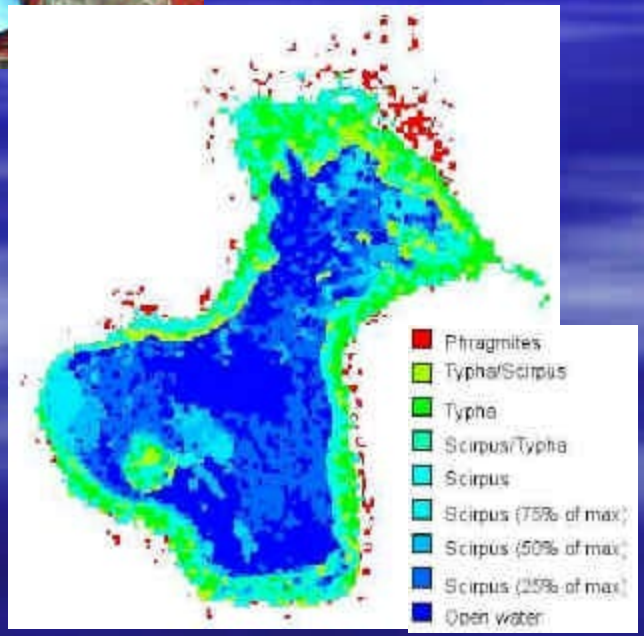
SPOT

Typical Remote Sensing Applications for Wetlands

- Inventory/Mapping
- Vegetative Biomass
- Monitoring
- Change Detection







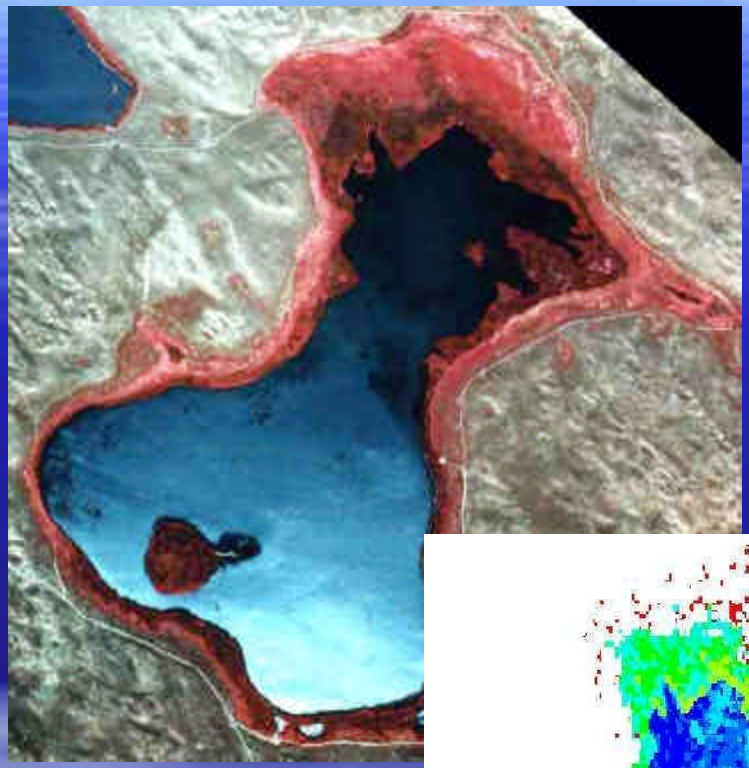
Remote Sensing of Wetlands: CALMIT Faculty and Projects

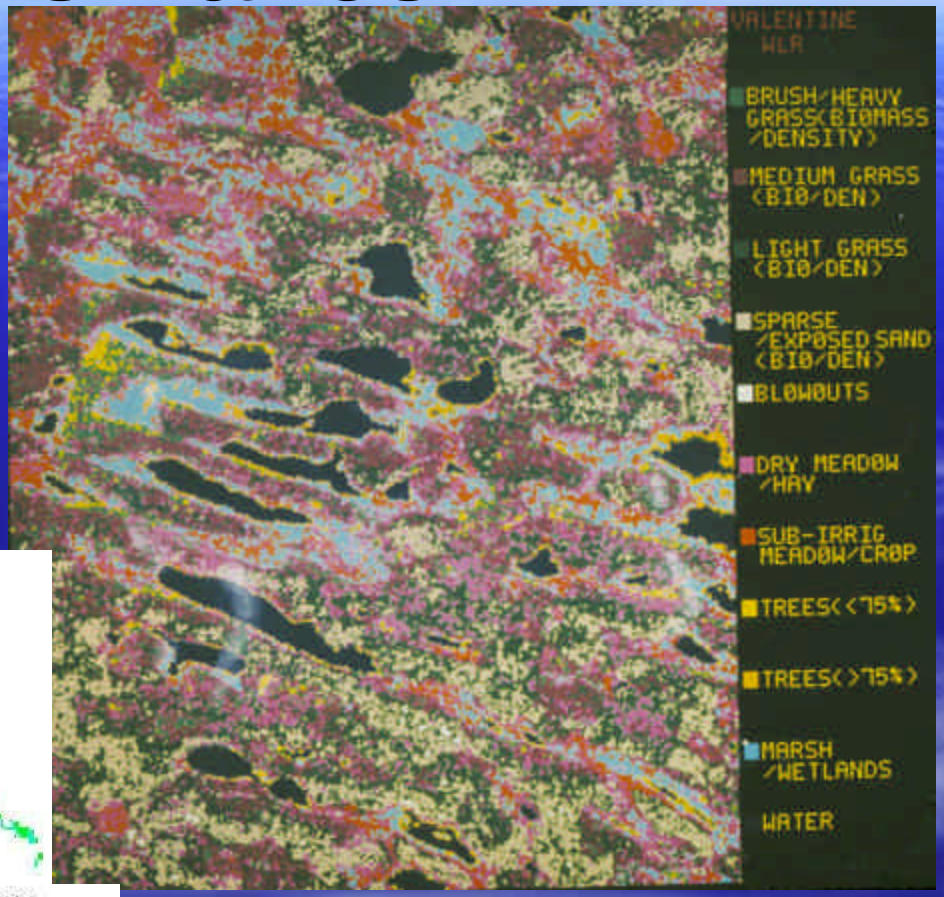
- CALMIT Faculty
  - Don Rundquist
  - James Merchant
  - Anatoly Gitelson
  - Sunil Narumalani
- CALMIT Selected Projects
  - Sandhills Lakes
  - Rainwater Basin
  - Whooping Cranes change detection
  - *In situ* wetlands assessment
  - Platte River wet meadows
  - Laboratory-based experiments

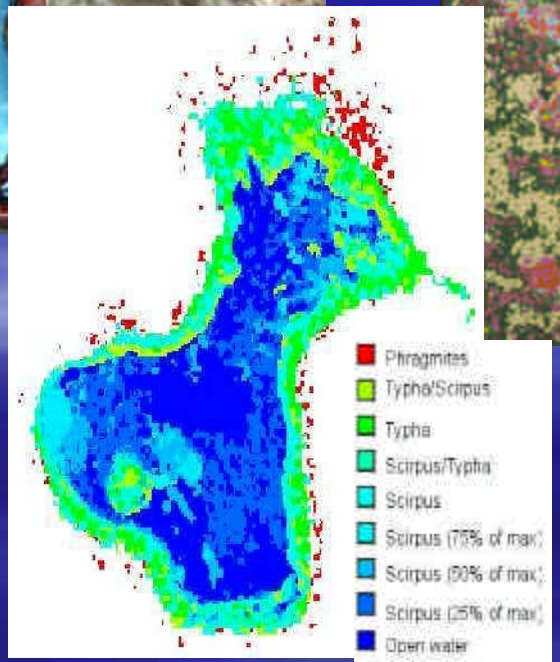
Sandhills Lakes

- Using RS for mapping, inventory, and classification of wetlands in the Nebraska Sandhills
- Variety of sensors
  - 1970s: Landsat MSS (80-m, 4 bands)
  - 1980s: Landsat TM (30-m, 7 bands)
  - 1990s: *In situ* hyperspectral

Sandhills Lakes







Rainwater Basin

- Nebraska's Rainwater Basin is an internationally significant staging area for migratory water birds of the Central Flyway
- Used as Spring staging area, and Fall migration habitat for endangered species, for a variety of birds.
- General trend is dramatic decline in wetlands

Rainwater Basin Wetland Trends

	Acres	No. of Basins
Historic	94,695	3,907
1960's	32,529	685
1980's	20,942	374

Source: Nebraska Game and Parks Commission

Rainwater Basin

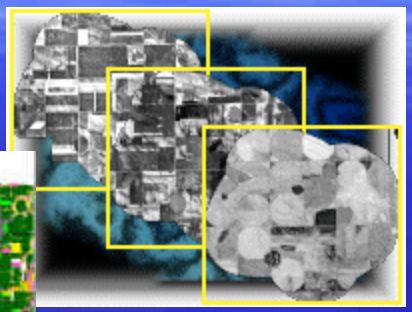
- Objectives:
  - Develop detailed digital databases for 87 publicly owned wetland basins found within the Rainwater Basin area
  - Use these databases for assessing individual wetlands and their uplands
  - Identify and prioritize areas of special concern
  - Select target sites for restoration projects
  - Develop long-term management plans for the wetland basins

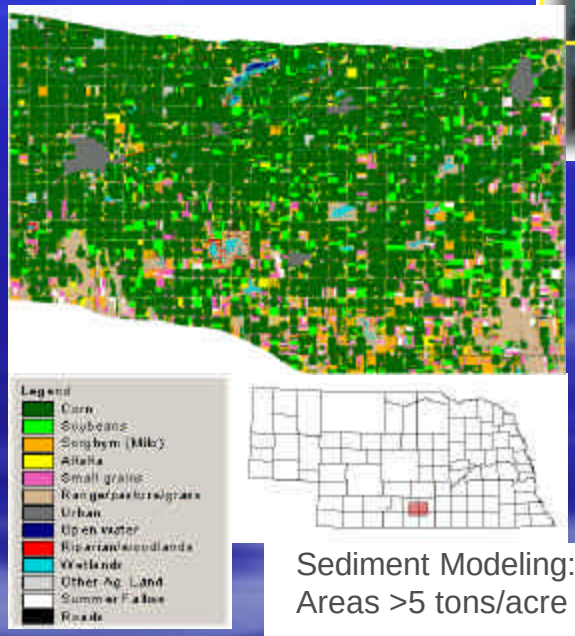
Rainwater Basin

Databases

- Wetland watershed boundaries
- USGS 1:24,000 quadrangle boundaries
- USGS 1:24,000 digital raster graphics
- 30 meter digital elevation data including slope and contours
- Digital orthophoto quarter quadrangles
- Digital soils data
- National Wetlands Inventory data
- Land ownership data
- Land cover and land use data
- Drainage structures
- Sediment sources
- Public land survey system data
- Historical aerial photography for selected wetland areas

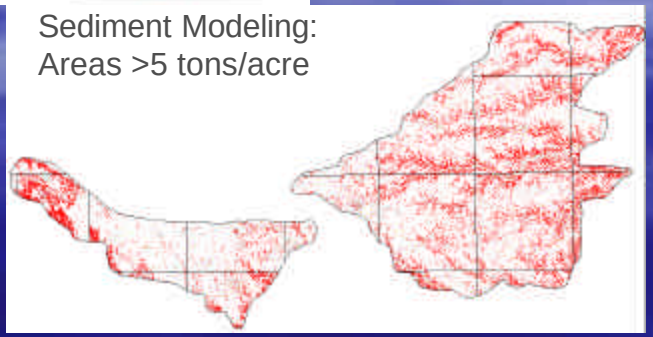
Historic Data





Contemporary Land Cover

Sediment Modeling:
Areas >5 tons/acre



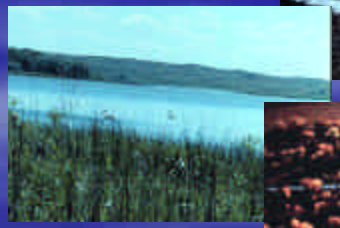
Modeling for Management

Whooping Cranes

- Endangered species
- Flyway extends from Woods Buffalo National Park in Northwest Territories/Alberta, Canada to Aransas National Wildlife Refuge in Texas
- North-South corridor through the Midwest (ND, SD, NE, KS, OK, TX)
- Assessment of wetland habitats and the change from 1981-1992
- Three study areas: Central Platte River, western Rainwater Basin, and the Central Table Playas

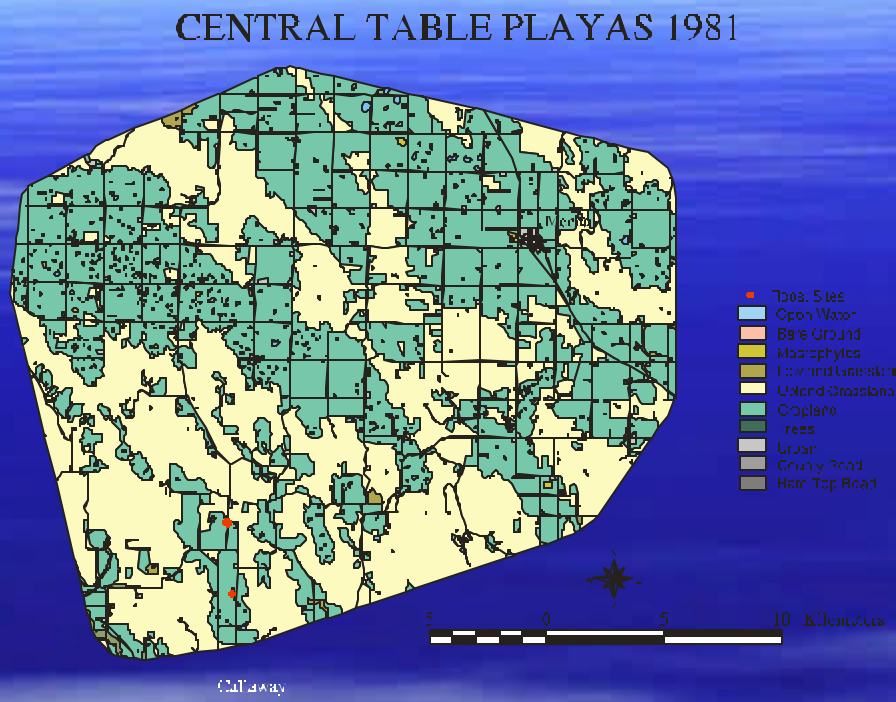
Central Table Playas

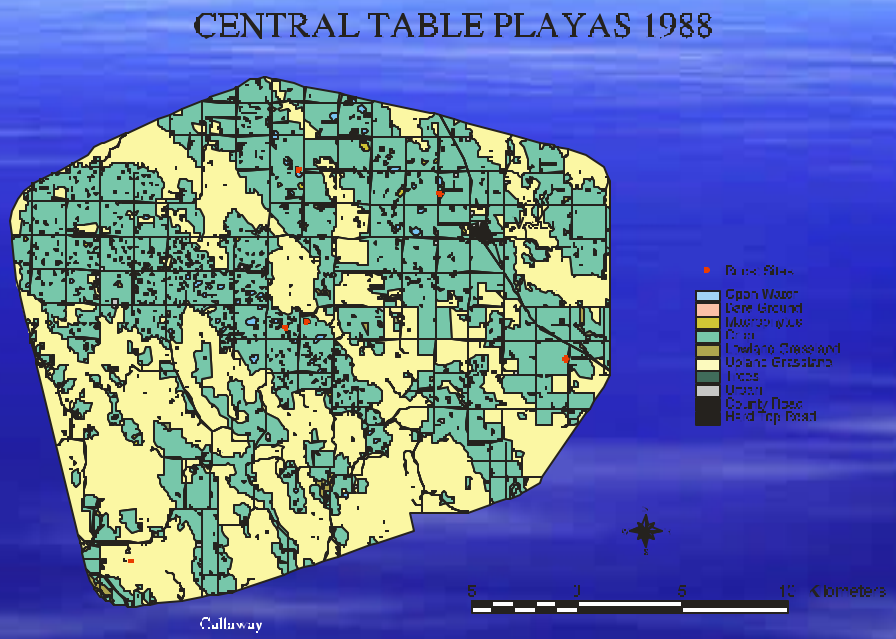
Rainwater Basin



Platte River

Whooping Cranes

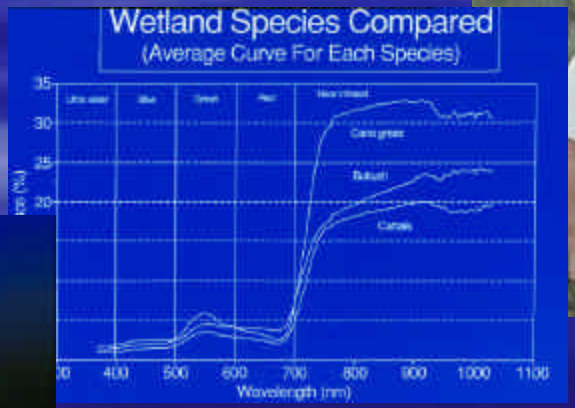


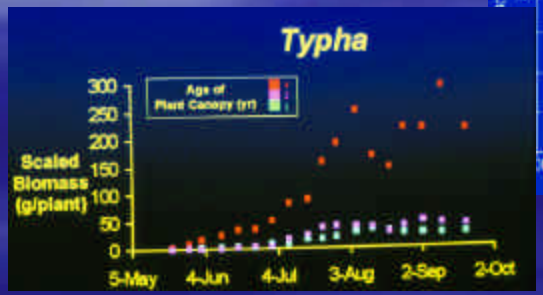


Interesting results: For all three sites (RWB, Platte, CTP), between 1981-1988, a general increase of approximately 10-25% in the landscape composition of wetlands. Decline of between 20-50% between 1988-1992. Increase shown during first period may have been the result of aerial photography acquired after rainfall events.

In Situ Wetlands Assessment

- Developed plots of various species
- Hand-held or boom mounted data acquisition
- Focus on spectral characterization and vegetation biomass



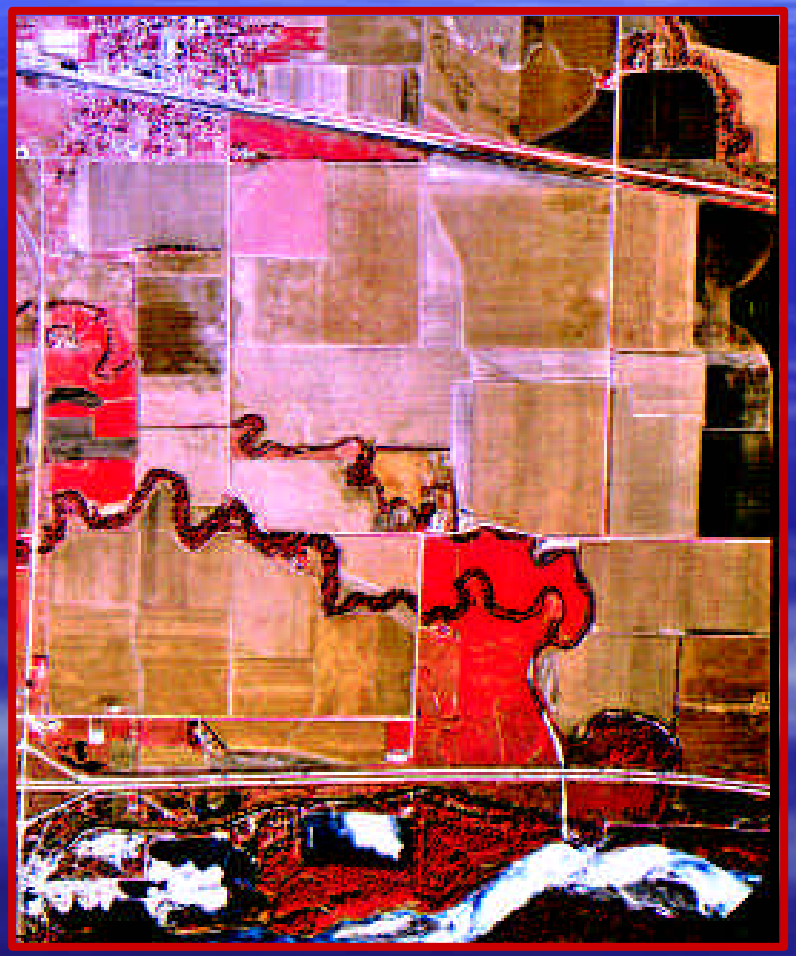


Platte River: Wet Meadows

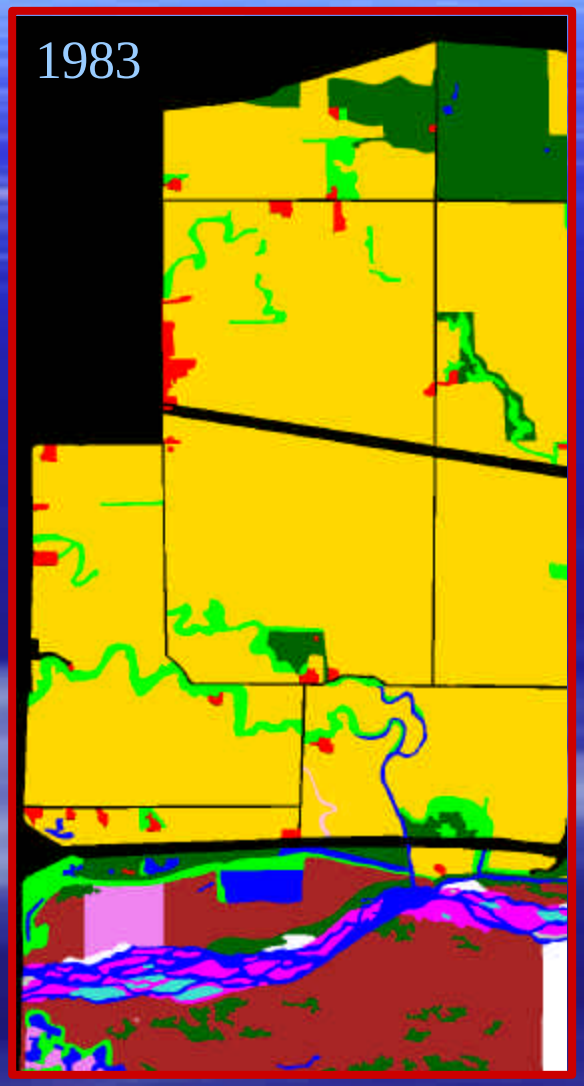
- There has been major controversy over the use of the Platte's water supply
- Reduced water flows have resulted in changes of channel morphology and increased woodland vegetation.
- Wet meadows and other native grassland habitats have declined substantially

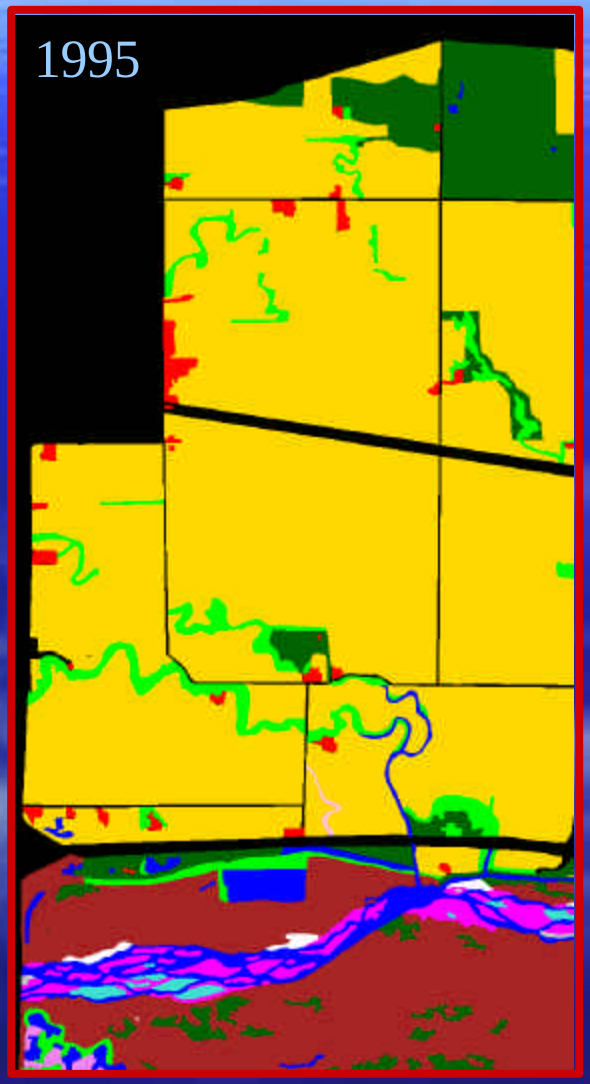
Platte River: Wet Meadows

- Utilize the multi-temporal data sets -
  - 1983 MOSS and
  - USFWS 1995 aerial photography
  - and USGS DOQQ's for the portion of the Platte River valley between Lexington and Chapman, NE
  - to perform a change detection study



Platte River: Wet Meadows





Laboratory-based Experiments

- What is the spectral response of various wetland vegetation based on canopy cover and water depth (for submerged vegetation)?

Laboratory-based Experiments

(a)

(b)

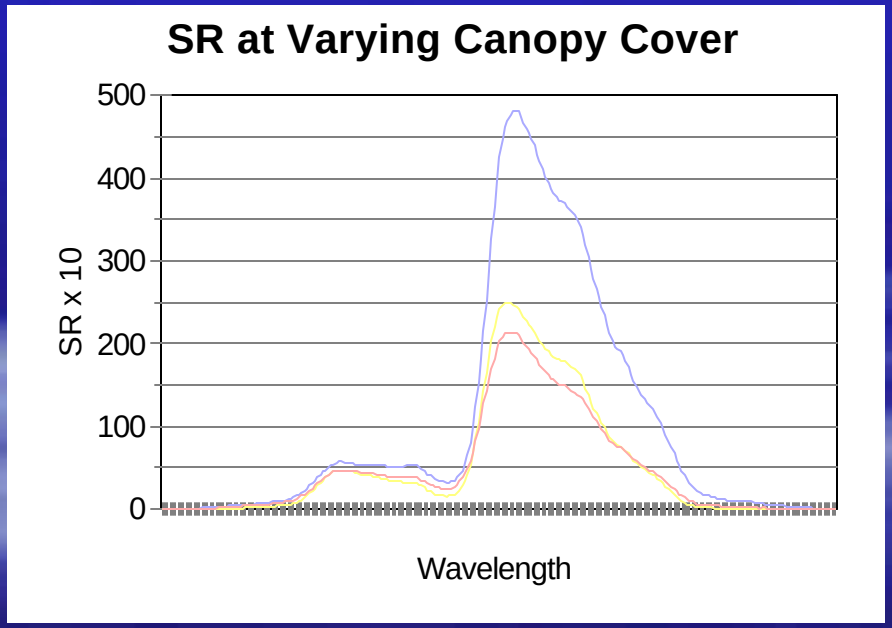
(c)

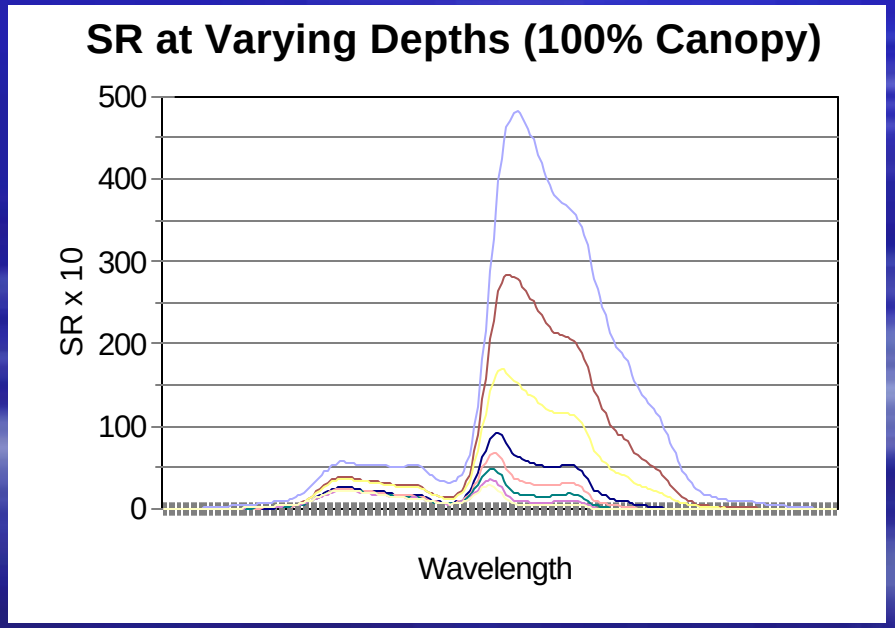
Number of plants were reduced by 33% during each iteration

Laboratory-based Experiments

- Spectral reflectance of Ceratophyllm with variable canopy cover (1/3 less at each data acquisition)

(b) Spectral reflectance of Ceratophyllm with 100% canopy cover at variable water depths (from surface to 70cm depth – 10 cm intervals)





Issues to Consider

- Detailed spectral characterization of species
- Multi-stage hyperspectral remote sensing
- Knowledge-based wetlands detection
- Assessing impact of water beneath canopy
  - Impact on spectral signatures
  - Spatial distribution of water
  - Wet soil
- Characterizing the vegetative canopy architecture
- Pigmentation analysis